TOKAI CARBON CB
Building a Future of Technology and Trust

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January 3, 2019

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Division Chief
Environmental Protection Division
Office of the Attorney General of Texas
P.O. Box 12548, MC 066
Austin, TX 78711-2548

Re: Tokai Carbon CB
Borger Plant – Alternative Control Technology

Dear Sir/Madame:

Per Provision 19 of Civil Action No. 3:17-cv-01792-SDD-RLB, Tokai Carbon CB hereby submits the enclosed alternative control technology specifications for your review and approval. This technology is the Haldor-Topsoe SNOX process, and it will control SO_2, NOx, and PM emissions. With this submission, please disregard the specifications for the control system that we submitted to you on May 9, 2018.

Sincerely,

Long Nguyen
Environmental, Health & Safety Manager

TOKAI CARBON CB	PROCESS SPECIFICATION
Project Name	Borger's SNOx Control System - Boilers
Plant Name	Borger Plant
Date	12/13/2018
Rev	02

Project Name:	**Borger's SNOx Control System - Boilers**
Objective	Install Haldor-Topsoe SNOx equipment downstream of the existing boilers discharge to reduce the emission level of NOx to below 39 ppm at 0% O_2 and SO_2 to below 80 ppm at 0% O_2.
Justification/ Benefits	The Borger plant produces carbon black with feedstock oil containing excess sulfur in a high temperature environment. Natural gas combustion is used as the primary source of heat in the carbon black reactors. The resulting tail gas from the process is partially used in the drying process (30% - 35%). The remaining tail gas is combusted in two boilers to generate steam for plant consumption and power generation. The flue gases from each boiler are combined into a single stack for discharge. The consent decree (CD) with the EPA requires that the boilers flue gas be treated for NO_x and SO_2 reduction. - NO_x is approximately 300 ppmvd and has to be reduced to below 39 ppm (dry, 0% O_2) on a 365 days rolling average. - SO_2 is estimated to be 2,660 ppmvd at the worst case feedstock scenario of 4% S. This must be reduced to below 80 ppm (dry, 0% O_2) on a 365 days rolling average. The SNOx system proposed will achieve the following: 1. Achieve the stated NO_x and SO_2 reduction 2. Produce a minimum 93% concentration sulfuric acid that will be sold into the market Refer to attached process specification for additional details. Refer to attached process flow diagram.
Yield/Production	Will increase the cost of production of carbon black
Quality	No impact on quality
Environmental	Greatly reduce the environmental impact of emissions from the Plant This process will eliminate the need for any waste landfill
Process Description	1. Tubes will be removed from existing boilers to achieve a flue gas temperature of ~650 °F. Current flue gas temperature of ~535 °F is too low for SNOx operation. 2. Two ID fans will be installed to convey the flue gas from the boilers to the SNO_x system 3. Install a natural gas duct burner (~25-30 MMBtu/hr) to re-heat the flue gas to ~750 °F – the required inlet temperature for SNO_x 4. Modify the existing stack to fit the duct burner and create a common header upstream of the SNO_x reactor. 5. Ammonia (19% concentration) will be injected in the duct at the inlet of the SNOx reactor. The use of static mixers will ensure thorough mixing of ammonia and flue gas 6. The reactor is equipped with 2 catalyst beds - the first to remove NO_x via the ammonia reaction and the second to convert the SO_2 into SO_3. This is an exothermic reaction and the flue gas will exit the reactor at ~766 °F. 7. A waste heat process boiler installed at the discharge of the reactor will cool the flue gas temperature to the desired ~482 °F for condenser inlet. Saturated steam produced (~100,000 lbs/hr,) will be used in the plant and condensed for water recycle to the boiler. 8. Supply of boiler feed water to the waste heat process boiler will be done via the plant's existing boiler feed water pumps 9. The flue gas is further cooled in WSA condenser modules with ambient cooling air, delivered by 2 fans. All of the SO_3 is converted to approximately 90% sulfuric acid. This will be further concentrated to at least 93%. 10. A small quantity of combusted silicone oil (50 to 100 g/hr) will be injected upstream of the WSA condenser to facilitate condensation of the sulfuric acid
Safety	Appropriate HAZOP and safety reviewed will be conducted prior to the start of the project. Operating procedures will be developed and operators trained in the safe operation of the equipment
MOC	Will an MOC be required (Refer MOC Procedure)? Yes – will be done during the AFE approval process

APPROVAL REQUIRED BY:

1. **Plant Manager, Process Engineering Manager, Engineering Director, Manufacturing Director and VP – Production and Engineering via Redmine**

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Line#	PROCESS DESIGN SPECIFICATION - CORPORATE ENGINEERING		Design	Minimum	
1	BORGER BOILERS - SNOx DESIGN SPECIFICATIONS				
2	Rev 2				
3	Average Tail Gas Composition to Burners		Design	Minimum	
4	H2O	%	49.21%	47.27%	
5	N2	%	32.41%	33.65%	
6	H2	%	7.96%	8.27%	
7	H2S	%			NOTE 1
8	Arg/O2	%	0.38%	0.39%	
9	CH4	%	0.22%	0.23%	
10	CO	%	7.32%	7.60%	
11	CO2	%	2.10%	2.18%	
12	C2H2	%	0.41%	0.42%	
13	Total	%	100.00%	100.00%	
14	Tail Gas Flows				
15	Total Tail Gas Generated	SCFH	9,252,717	1,847,123	
16		Nm3/hr	247,889	49,486	
17	% Tail Gas to Boiler	%	70%	65%	
18	Tail Gas Flow available to boilers	SCFH	6,476,902	1,200,630	
19		Nm3/hr	173,523	32,166	
20	Reheat Natural Gas	SCFH	25,000	4,684	
21		Nm3/hr	670	125	
22					

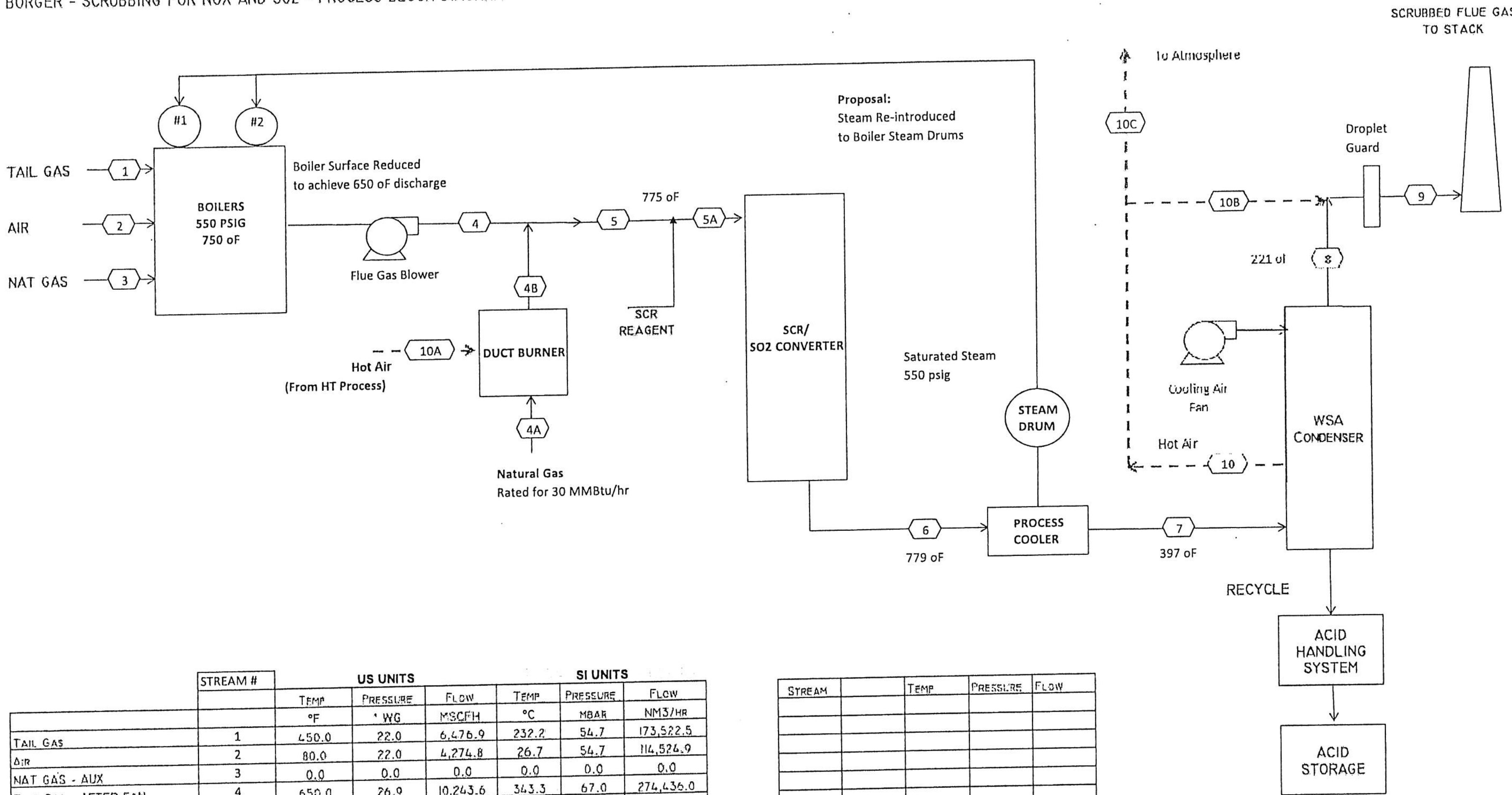
COMMENTS

Line#	PROCESS SPECIFICATIONS FOR SCRUBBING EQUIPMENT- BORGER BOILERS	Units	MAX BOILERS FLUE GAS	MAX FLUE GAS FROM NG REHEATING	DESIGN/MAX CONDITIONS	NORMAL CONDITIONS	MINIMUM CONDITIONS	COMMENTS
23	PROCESS SPECIFICATIONS FOR SCRUBBING EQUIPMENT- BORGER BOILERS							
24			MAX BOILERS FLUE GAS	MAX FLUE GAS FROM NG REHEATING	DESIGN/MAX CONDITIONS	NORMAL CONDITIONS	MINIMUM CONDITIONS	
25								
26								
27								<— Minimum flow based on Unit 1 in Operation
28	Sulfur in Oil				4.0%	2.5%	2.0%	
29	Flue Gas Flow from Stack (Wet)	SCFH	10,243,599	275,294	10,518,894	9,442,126	1,979,301	<— Minimum flow based on Unit 1 in Operation
30		SCFM	170,727	4,588	175,315	157,369	32,988	
31		Nm3/hr	274,436	7,375	281,811	252,964	53,027	
32								
33	Flue Gas Temperature (BOILER DISCHARGE)	oF	650	3,738	750	750	750	<— Boiler Tubes Reduced to achieve 650 oF at discharge
34		oC	343	2,059	399	399	399	<— NG Burner will maintain required temp at SNOx Reactor
35	Flue Gas Pressure (BOILER DISCHARGE)	inH2Og	0.0		0	0	0	<— Typical fluctuation in pressure is 0 to -1 inH2Og
36		barG	0.0		0	0	0	
37								
38	Actual Flue Gas From Stack (Wet) - *NOTE 2*	ACFH	21,866,145	2,222,471	24,476,656	21,971,101	4,605,682	
39		ACFM	364,436	37,041	407,944	366,185	76,761	
40		m3/hr	619,180	62,933	693,101	622,152	130,418	
41								
42	Flue Gas Composition - % Wet							
43		H2O	36.7%	18.0%	36.2%	36.2%	35.3%	<— Typical fluctuation in H2O% are 32% to 40%
44		N2	53.5%	71.8%	53.9%	53.9%	54.7%	
45		Arg	0.2%	0.0%	0.2%	0.2%	0.2%	
46		CO2	6.6%	9.2%	6.7%	6.7%	6.8%	
47		O2	3.0%	1.0%	3.0%	3.0%	3.0%	<— Typical fluctuation in O2% are 2% to 4%
48		Total	100.0%	100.0%	100.0%	100.0%	100.0%	
49								
50	Flue Gas Dry - Flow	SCFH	6,485,766	225,851	6,711,618	6,024,582	1,280,842	
51	Flue Gas Flow Composition % -Dry	N2	84.4%	87.6%	84.5%	87.5%	84.5%	
52		Arg	0.4%	0.0%	0.4%	0.0%	0.4%	
53		CO2	10.4%	11.2%	10.5%	11.2%	10.5%	
54		O2	4.8%	1.2%	4.6%	1.3%	4.7%	
55	UNTREATED POLLUTANTS BREAKDOWN							
56			BOILERS	NG HEATING	TOTAL	TOTAL	TOTAL	
57	NOTE 1)		PPM (Dry)	PPM (Dry)	PPM (Dry)	PPM (Dry)	PPM (Dry)	
58	NOx (dry at given O2%)	PPM	302	21	293	293	293	
59	SO2 (dry at given O2%)	PPM	2,660	-	2,570	1,277	687	
60	SO3 (dry at given O2%)	PPM	15.0	-	14.50	14.50	14.29	
61	Inlet PM	grains/dscf	0.020	-	0.02	0.02	0.02	<— Under Max,Norm, and Min Conditions (Method 5 EPA)
62	Inlet PM	mg/Nm3(dry)	48.4	-	48.42	48.42	48.42	<— Under Max,Norm, and Min Conditions (Method 5 EPA)
63	Max Inlet PM intermittent Bag Failure (<0.5 hrs)	grains/dscf	1.24	-	1.24	1.24	1.24	<— Under Bag Failure Conditions (Method 5 EPA)
64	Max Inlet PM intermittent Bag Failure (<0.5 hrs)	mg/Nm3	3,000	-	3,000	3,000	3,000	<— Under Bag Failure Conditions (Method 5 EPA)
65								
66			BOILERS	NG HEATING	TOTAL	TOTAL	TOTAL	
67			LB/HR	PPM (Dry)	LB/HR	LB/HR	LB/HR	
68	NOx	LBS/HR	237	1	238	214	45	
69	SO2	LBS/HR	2,910.0	-	2,910	1,298	148	
70	SO3	LBS/HR	20.5	-	21	18	4	
71								
72	DESIGN SPECIFICATIONS FOR POLLUTION CONTROLS							
73								
75	Guarantee NOx outlet, ppm (dry) @ 0% O2 - less than				39	39	39	<—- on a 365-day rolling average
78	Guarantee SO2 outlet, ppm (dry) @ 0% O2 - less than				80	80	80	<—- on a 365-day rolling average
80	PM emissions at final stack , grains/dscf - less than				0.0069	0.0069	0.0069	<—- on a 3-hr rolling average
81	PM emissions at final stack , mg/Nm3 - less than				16.70	16.70	16.70	<—- on a 3-hr rolling average
82	Ammonia Slip at final stack ppm(dry) @ 3% O2 - less than				10.0	10.0	10.0	<—- State Requirement
83	SO3 emissionsat final stack ppm(dry) @ 0% O2 - less than				10.0	10.0	10.0	

84
85 NOTES
86 1) H2S in the tail gas converts to SO2 after combustion. This typically varies with the %S in the feedstock oil.
87 Max/Design case is based on 4% S in the feedstock. Normal and min cases are based on 2.5% and 2.0% sulfur
88 2) Actual conditions corrected for temperature. Actual pressure assumed to be at 1 atm
89
90 APPROVALS:
91 R. Ali | L. Nguyen | A. J. Bahr | P. Pitmann | S. Honea | R. Bismilla

Revisions
- 0 Original Case
- 1 Updated grade mix and tail gas split for Max/Design Case
- 2 Specified duct burner BTUs, ammonia slip,
- 2 Specified SO3 discharger from stack
- 2 Added normal case based on typical capacity and 2.5% S
- 2 Minimum Case corrected for 2.0% sulfur

BORGER - SCRUBBING FOR NOX AND SO2 - PROCESS BLOCK DIAGRAM



	STREAM #	US UNITS			SI UNITS		
		TEMP	PRESSURE	FLOW	TEMP	PRESSURE	FLOW
		°F	" WG	MSCFH	°C	MBAR	NM3/HR
TAIL GAS	1	450.0	22.0	6,476.9	232.2	54.7	173,522.5
AIR	2	80.0	22.0	4,274.8	26.7	54.7	114,524.9
NAT GAS - AUX	3	0.0	0.0	0.0	0.0	0.0	0.0
FLUE GAS - AFTER FAN	4	650.0	26.9	10,243.6	343.3	67.0	274,436.0
FG - AFTER NG BURNER*	5	782.6	25.7	10,558.6	417.0	64.0	282,874.0
FG - INLET TO SNOX*	5A	784.4	24.5	10,596.4	418.0	61.0	283,889.0

* - DATA FROM HALDER-TOPSOE

STREAM		TEMP	PRESSURE	FLOW

UNTREATED POLLUTANTS

STREAM	POLLUTANT	LB/HR	PPM DRY
4	NOX	238	302
4	SO2	2,910	2,660

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CORPORATE ENGINEERING			REV 2- 12/20/2018
DRAWN BY:	ROSHAN ALI		
REVISED BY:	ROSHAN ALI		
APPROVED BY:	STEVE HONEA		
APPROVED BY:	ANDY BAHR		